Space Weather Technical Forecast

Issued on Friday, 25 March 2022 at 00:57 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance R1/R2 Radio Blackouts throughout. Chance G1/Minor Storm day 2 and 3 (26th and 27th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with peak flare of C8.2 at 24/0145 UTC from the coupled pair of sunspot regions AR2975 Cao/Beta and recently numbered AR2976 Eki/Beta following. While the first region has shown some sign of decline, the following region has shown further slight development and is the most likely source for any further activity on the disc. A third sunspot region AR2974 Hrx/alpha is visible in the southeast disc, but is both small and gradually decaying despite recent C1-flaring. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR at L1 increased from 450km/s, to be elevated at 550-600km/s around 24/0700-1620 UTC, before declining back to around 500km/s at the end of the period. The density was around average throughout. The strength of the interplanetary magnetic field (IMF) Bt, declined from an initial peak of 10nT, to be weak at below 5nT from 24/1000 UTC, with the north south component Bz largely positive (northward) ranging -5nT to +7nT. The phi angle was predominately positive (away from the Sun). Geomagnetic activity was Active 24/0000-03000 (Kp4), but otherwise Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV) has been at Normal Background levels, and the 24-hour integrated electron fluence was below the Active (1e8 integrated pfu) threshold. Observed fluence at 25/0000UTC was 1.05e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is expected, with further C-flares expected from AR2976 and AR2975 in the northeast disc. There is a chance (25%) of activity increasing to moderate with the occurrence of any M-flares (R1/R2 Radio blackouts).

Solar Wind / Geomagnetic Activity: A weak CME from the 20th may arrive early on day 1 (25th) but is expected to be very weak and largely imperceptible given recent fast wind enhancements from CH67. No other CME arrivals are expected. Current solar elevated solar winds are forecast to decline day 1 and 2 (25th/26th) as the fast wind of CH67 eases, before the arrival of a further fast wind from CH69 later day 2 (26th). Solar winds are likely to reach 500-600 km/s, before easing again later day 3 and day 4 (27th and 28th). Quiet, isolated Unsettled, geomagnetic activity at first is expected to become Active with a chance of G1/Minor Storm intervals later day 2 and day 3 (26th/27th), before easing to Quiet to Unsettled day 4 (28th)

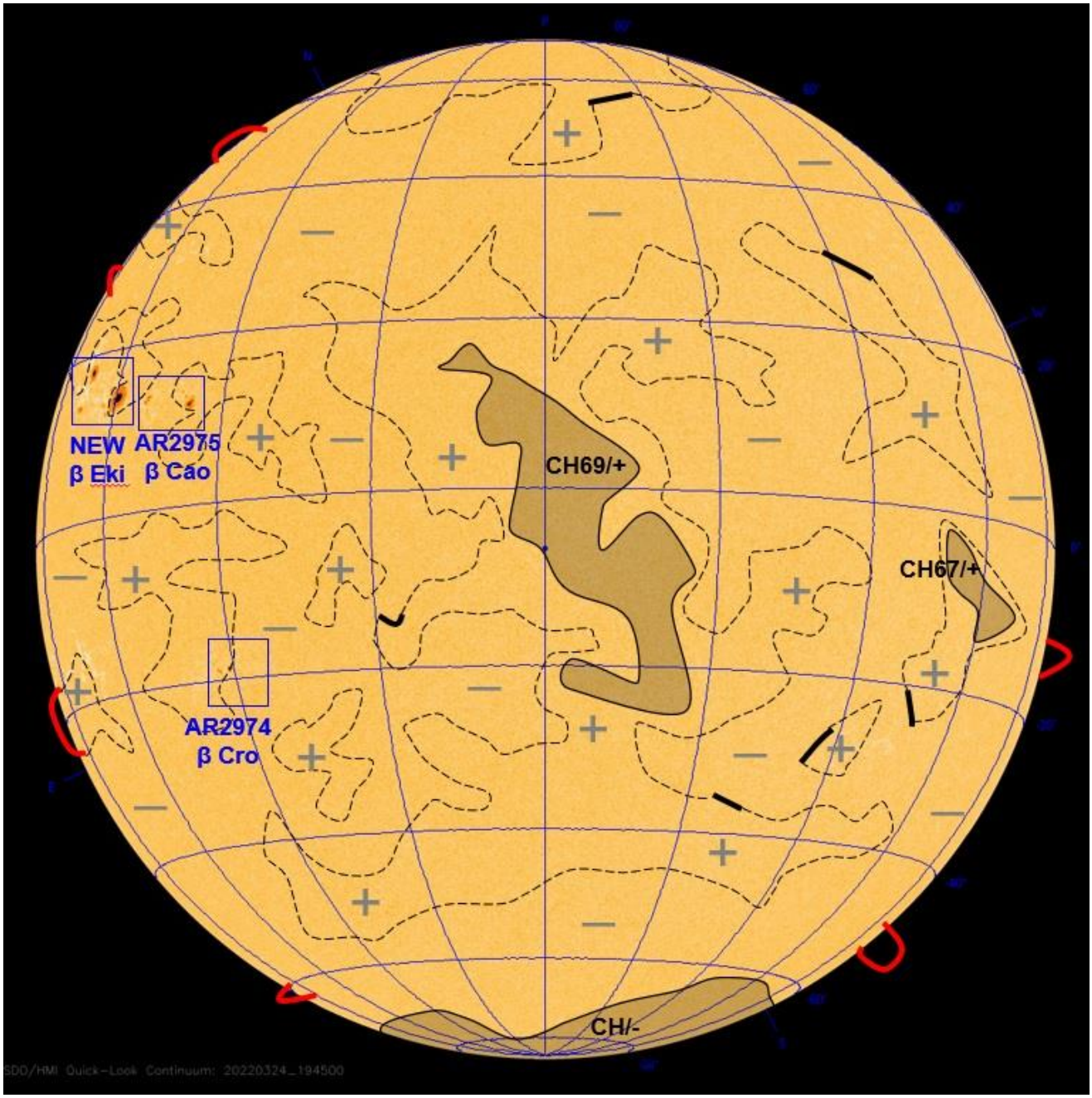
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels throughout the forecast period, with only a very slight chance of rising above background levels from the one large sunspot on the disc. The high energy (greater than 2 MeV) electron flux is currently at background, with a chance of rising to Moderate levels through days 1-2, (25-26th) before a larger but still low confidence chance of

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

rising in response to the fast wind of CH69 day 3 onward (27th). The associated 24 hr fluence will likely persist below the Active (1e8 integrated pfu) threshold but with a chance of rising above by the end of day 4 (28th).

Figure 1. Solar Analysis Valid 24/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A weak CME from the 20th may arrive early on day 1 (25th) but is expected to be very weak, and largely imperceptible given recent fast wind enhancements from CH67. No other CME arrivals are expected.

Current fast winds from CH67 are forecast to gradually decline day 1 and much of day 2 (25th and 26th) before the arrival of the next region of fast winds from CH69. This is an equator spanning hole, and recurrent from the previous rotation, where persistence would suggest arrival on the 27th with peak speeds just over 500 km/s. However, observations from STEREO A, indicate an earlier arrival on day 2 (26th), with peak speeds potentially in excess of 600 km/s. This is considered the more likely occurrence, although winds perhaps peaking just below 600km/s.

Mainly Quiet geomagnetic activity at first, with a slight chance of Unsettled spells is forecast to become Active with a chance of G1/Minor Geomagnetic storms on day 2 (26th), perhaps extending into day 3 (27th). Mainly Quiet to Unsettled conditions then likely returning by day 4 (28th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	40	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0745 UTC	Partial	Ex-2971	N09 E020	210 km/s	24/2300 UTC	Limited response expected. Low confidence of any hit.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: Enlil with ensemble

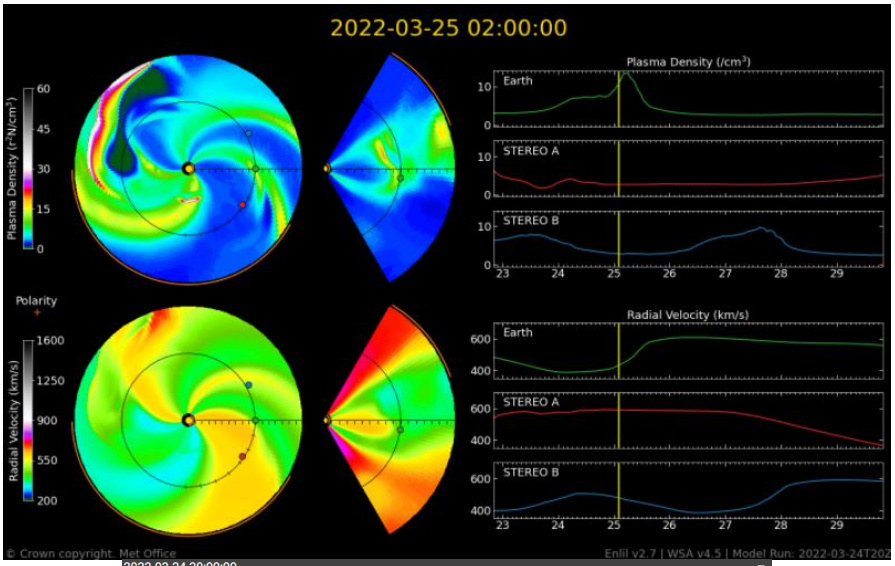
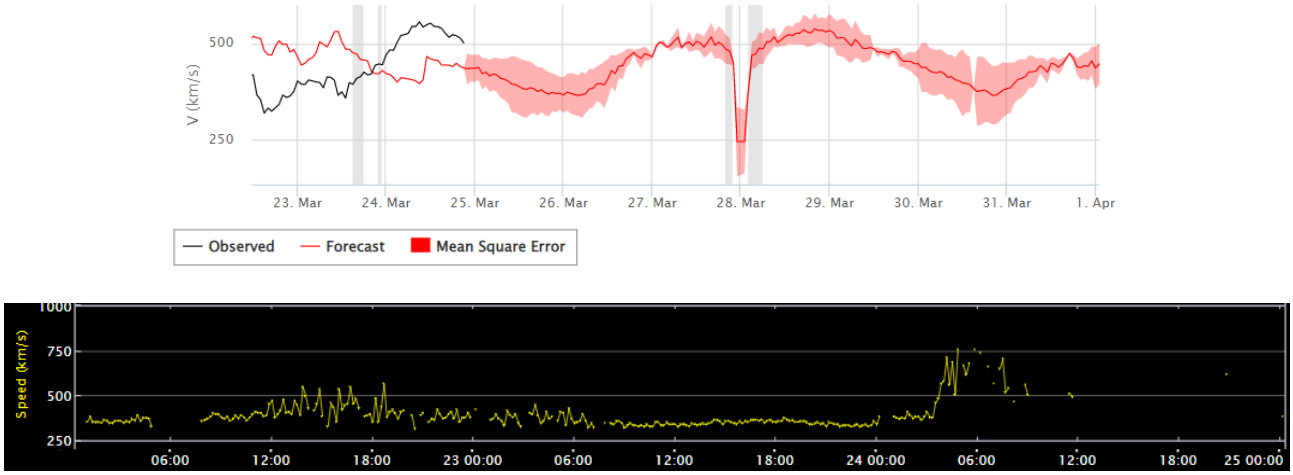


Figure 3: Solar wind persistence Model (top) and STEREO A PLASTIC solar wind speed (bottom – observing winds around 2.6 days before Earth). STEREO A suggests earlier arrival than SWPM.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

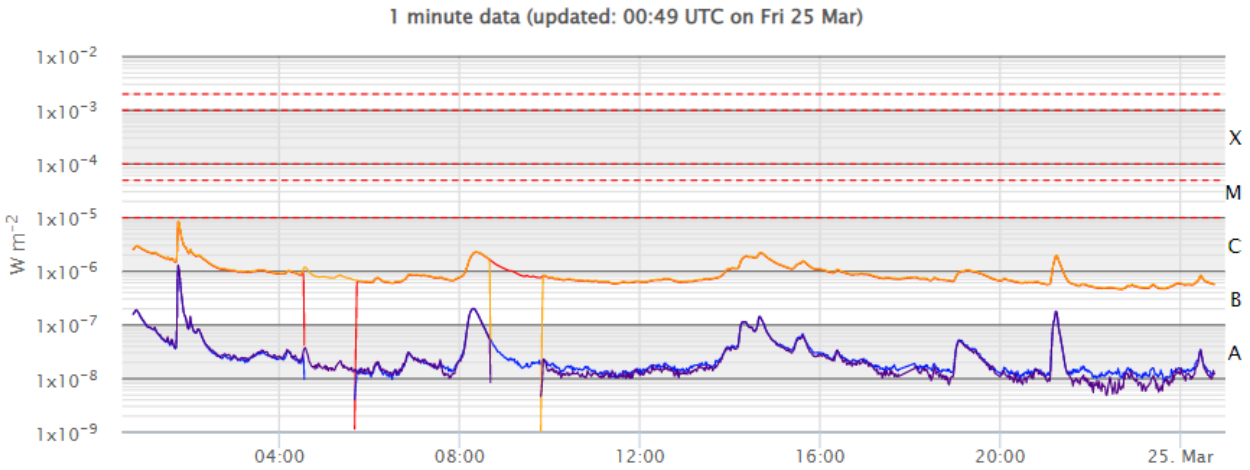
Radio Blackouts - X-Ray Flares:

There are three sunspot regions on the visible disc at time of issue. The largest is recently numbered AR2976 Eko/Beta just to the east of a smaller region AR2975 Cao/beta, with some magnetic coupling suggested between the two regions on SDO imagery. The unnumbered region has produced a number of C-flares, including the largest of the last 24 hours, a C8.2 at 24/0145 UTC, with further C-flare activity expected, while AR2975 has shown some signs of decline. The final region is AR2974, a small unipolar Hrx/alpha spot in the southeast that has also been declining despite recent C1 flare activity. Through day 2 and into day 3 (26th-27th), a bright region on STEREO A euvi, and also present on far-side analysis, is also expected to rotate onto the disc.

Solar Activity is expected to persist at Low levels, with a 25% chance of rising to Moderate, primarily from any M-flares that could occur from AR2975.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 4: GOES16-17 X-ray Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

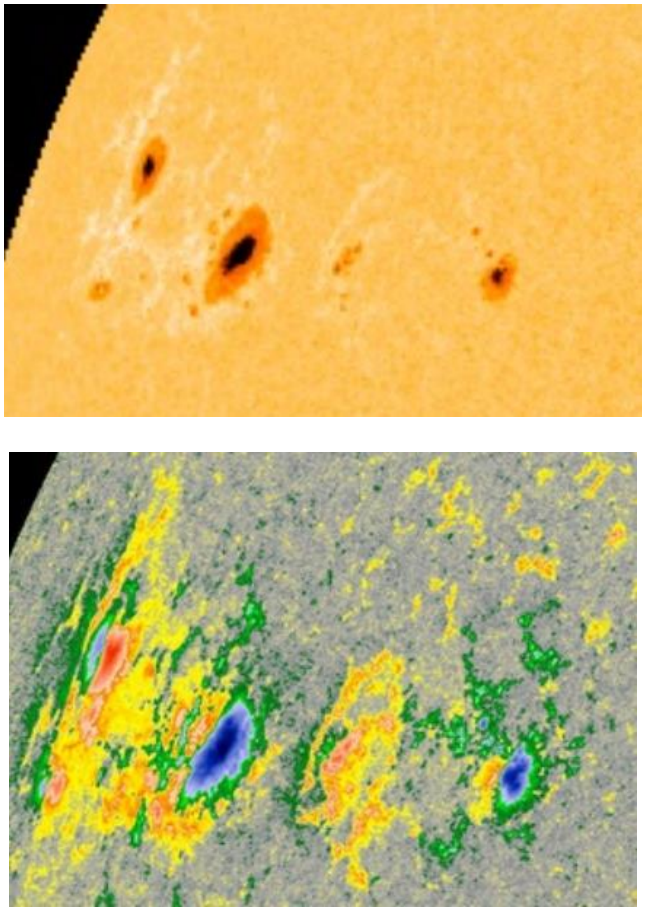
© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 is expected to remain at Background levels throughout the forecast period. However, there is a slightly above background chance of an increase in observed proton flux, due to the new, yet to be numbered active region in the northeast, although this is disfavoured due to its east-limb location.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: SDO Hmi Intensitygram and Magnetogram of AR2975 and AR2976



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

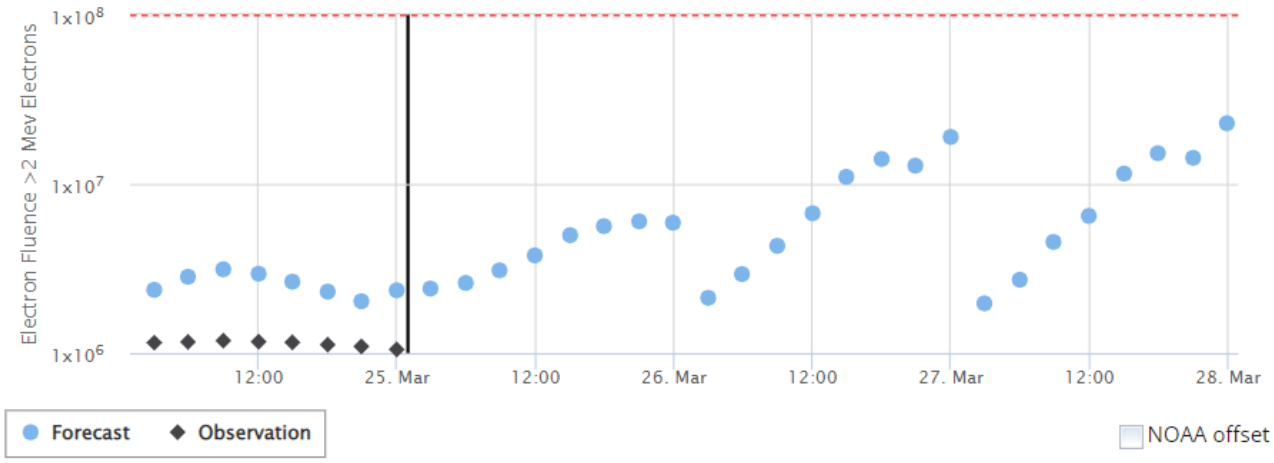
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently at Background and likely to persist at these levels through to day 3 (27th), perhaps peaking at Moderate levels due to recent fast wind enhancement. A potential further rise in then likely due to the arrival of the fast wind of CH69. Moderate, possibly peaking at High flux likely day 4 (28th) however confidence is low.

The associated 24 hour fluence is expected to rise through the period, perhaps initially from recent fast wind enhancements, but more generally from any subsequent moderate to high flux from the fast wind of CH69. This bringing a chance of Active fluence by the end of the period. REFM is currently giving good guidance, with fluence remaining below the Active threshold, but with a potential slight rising trend.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: >2 MeV Electron Fluence with REFM



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.